Space Weather Technical Forecast

Issued on Sunday, 21 April 2024 at 13:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated to occasional M-Class R1/R2 flares likely. Slight Chance G1/Minor geomagnetic storms throughout given the potential for CME influence.

Solar Activity: Solar activity, as measured at GOES16 and 18 is currently Low, with a peak flare of C7.5 at 20/1706UTC from AR3645.

There remain around thirteen active regions, although the partitioning of the central cluster comprising ARs 3637, 38, 47, 45, 43 and 50 remains complex. The main regions on the disc at present are AR3639 in the north and AR3645, the latter comprising the largest cluster of spots within the central western cluster. This spot saw growth of peripheral spots and spreading to become an Eki/Beta-Gamma, with a possible tenuous candidate for a Mt Wilson delta spot in the leader discounted for now. The final main region of note in terms of complexity was AR3647, although the growth trend here was more stable, taking the form of a Dkc/Beta-Gamma by the time of this analysis.

No new clear Earth-directed CMEs have been observed in available imagery. The M1.0 flare CME of 19 April was analysed, however unpicking its influence from the many minor CMEs in MOSWOC ENLIL is not possible - it is considered likely to add to the complexity of the forecast without dominating.

Solar Wind / Geomagnetic Activity: The solar wind as recorded by ACE at L1 was relatively turbulent, perhaps riding on or near the current sheet given frequent changes in phi angle, although this was perhaps slightly biased to negative territory overall (towards the Sun). There may be some influence of CH25/- in this signal.

Solar wind speeds showed a generally steady trend overall, remaining at Slightly Elevated levels near 450km/s. The solar wind density remaining below average throughout. The IMF remained on a stable trend around or below 5nT, although the north-south component was perhaps the most notable feature, as although only small-scale between +3 and -6nT, it was largely anti-aligned with Earth's field.

The net result of the above solar wind measures was for provisionally Quiet to Unsettled Kp indices.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background levels.

High energy electron flux (greater than 2MeV) observed at GOES16 was mainly at Normal Background levels. The associated 24-hour fluence remained below Active (1e8 integrated flux) with a value of 1.51e6 integrated pfu observed at 21/0001UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Isolated to occasional M-class flares likely, with a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast carries very low confidence in detail, however any enhancements are considered to peak in the G1/Minor Geomagnetic Storm range before midweek (UTC, and barring any new events).

There are a number of CMEs expected to pass near Earth, originating from the southeastern quadrant between 18 and 19 April, with the potential for weak glancing impacts throughout the period. Otherwise, fast wind influence from CH25/- may become more reliable over the remainder of the current UTC weekend before gradually and erratically easing into the new UTC working week.

Geomagnetic activity is expected to be generally Unsettled for much of the period, however any additional enhancement from CME arrivals will bring the potential for Active to G1 Minor Storm intervals, perhaps most likely in the 72-hour period of the UTC days of Sunday and Tuesday (21 and 23 April).

Energetic Particles / Solar Radiation: High energy proton flux carries a slowly increasing Slight Chance of S1 due to the number of more complex sunspot regions moving into the western solar hemisphere.

High energy electron flux as observed by GOES16 is expected to rise to Moderate, perhaps High levels into the new UTC week, however this may be limited by any glancing CME impacts that occur. The associated 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold but with an increasing trend, and a Slight Chance of reaching Active into the new working week UTC - depending on the CME influence.

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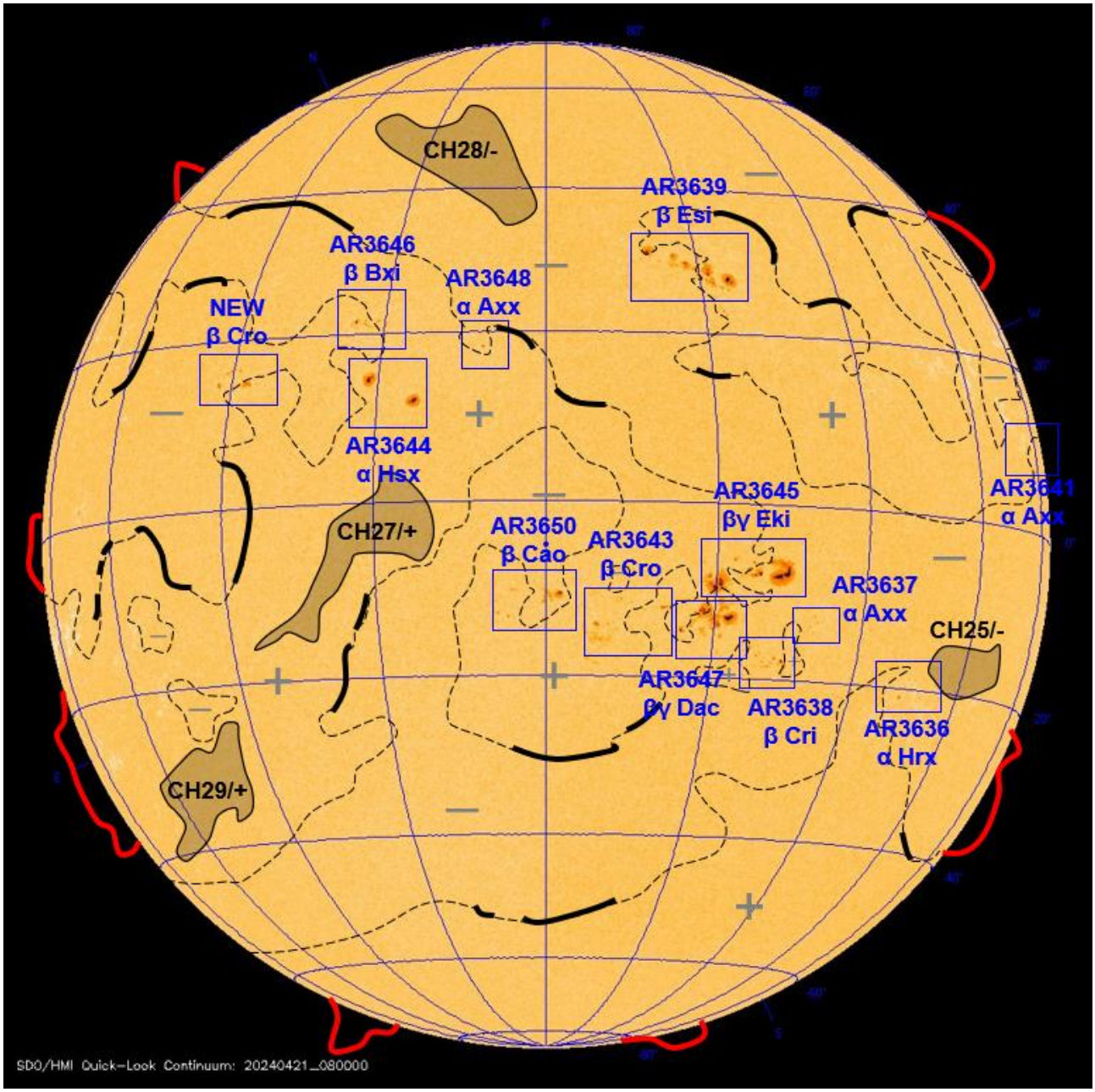
Figure 1. Solar Analysis Valid 21/0800UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast carries very low confidence in detail, however any enhancements are considered to peak in the G1/Minor Geomagnetic Storm range before midweek (UTC, and barring any new events).

The current CME forecast is complex, with MOSWOC ENLIL ensemble output showing a generally envelope of perturbed solutions between days 1 and 4 (21-25 April), with multiple minor CME arrivals considered possible (barring new events). The main source of potential enhancement being jet-like CMEs from AR3638 to end the last working week (UTC).

The other main consideration of the coming forecast period is influence from CH25/-, which if present has been hesitant in the past 24 hours, however this becomes more likely over the remainder of the current UTC weekend. CH25 itself is a small feature and should therefore have a limited tenure before the fast wind gradually and erratically eases to background slow wind conditions into the start of the working week.

Geomagnetic activity is expected to be generally Unsettled intervals for much of the period, however any additional enhancement from CME arrivals will bring the potential for Active to G1 Minor Storm intervals, perhaps most likely in the 72-hour period of the UTC days of Sunday and Tuesday (21 and 23 April).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	20	15
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Several CME candidates possibly inbound, all modelled as of glancing incidence and mainly passing 1AU between 21 and 23 April inclusive. Main sources are likely CMEs from the region of AR3637 and AR3638 in the period 18 and 19 April.

Figure 2: Latest MOSWOC ENLIL Ensemble output

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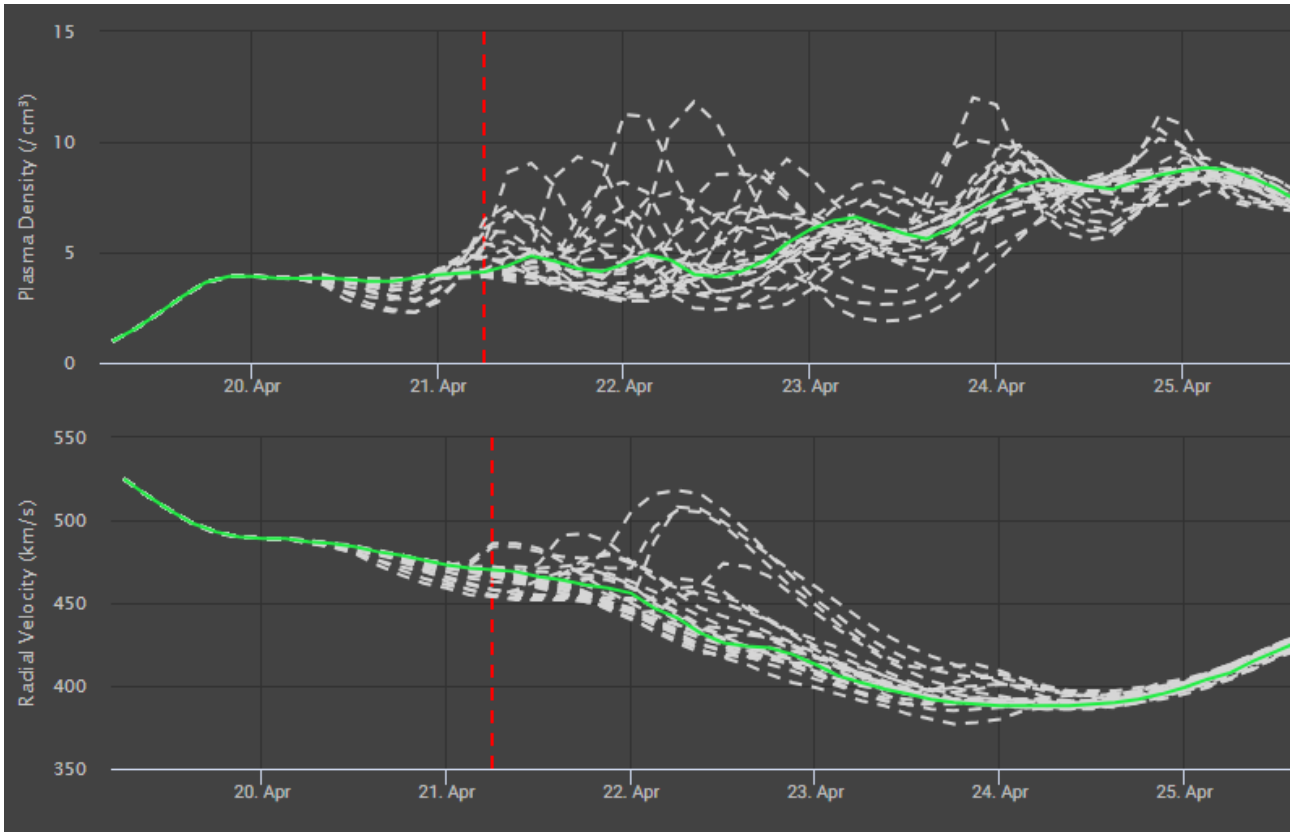

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Radio Blackouts - X-Ray Flares:
The Penticton 10.7cm value is currently slightly reduced on its high of 227sfu reached on Thursday 18 April, however it remains high at 210sfu, and this is largely the result of the large mass of sunspot regions in the central southern disk. The exact apportionment of active regions within this large plage area is somewhat subjective, however some simplification and consolidation in magnetic imagery in recent hours makes the process more straightforward. The main part of this region is AR3645 in the north of the group, which has shown a tendency to approximations of minor Mt Wilson delta spots, which when coupled with its Zurich complexity and penchant for producing jet-like CMEs makes it perhaps the spot group to watch at present. The other main groups are AR3639 in the northwest, and AR3647 to the south of AR3645. Both of these have filaments in relatively close proximity which are an additional source for possible CMEs as well as the regions themselves.

No significant regions are due to arrive or leave in the period with flare probabilities maintained pending further developments in the coming days. Isolated to occasional M-class flares likely, with a slight chance of isolated X-class flares. Daily probabilities are held near the raw values for the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):
High energy proton flux as observed by GOES18 has persisted at Background levels. There is a gradually increasing Slight Chance of the solar radiation trace reaching S1 in response to any notable flares, as the large agglomeration of centre-disc active regions traverses westwards. There is no significant reducing contribution from any departed regions on the far side, and the overall trend is therefore slightly upwards in the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	20
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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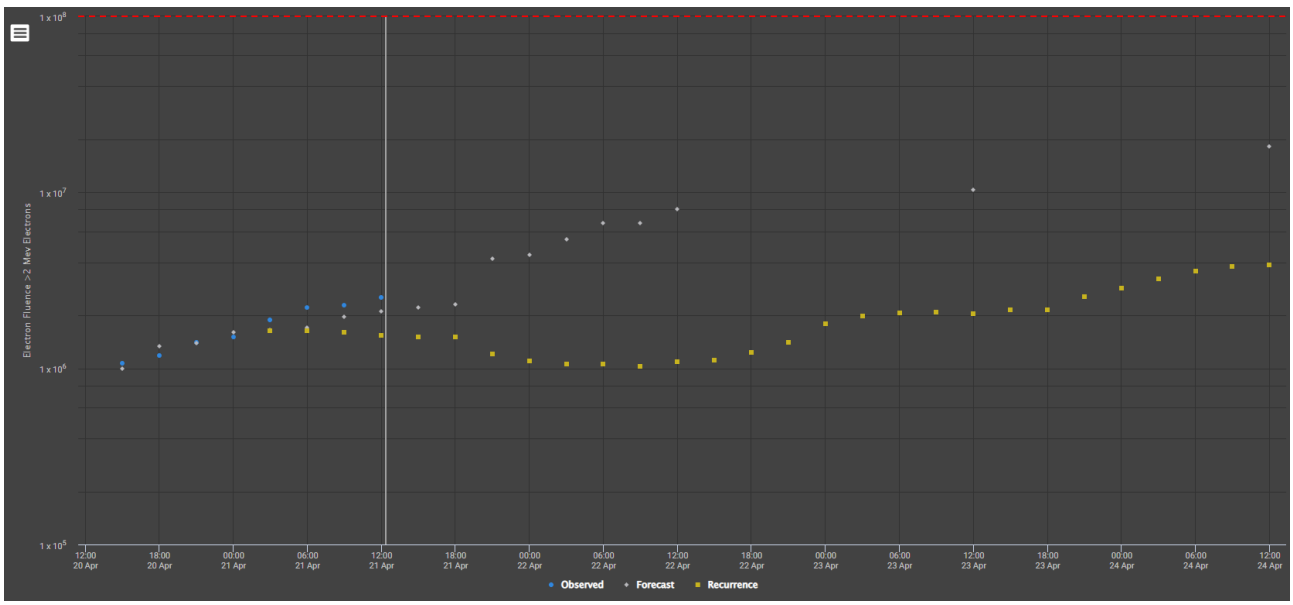
High Energy Electrons Event (≥ 2MeV):
High energy electron flux as observed by GOES16 has persisted at mainly Normal Background levels, with the ongoing enhanced solar wind environment due to the CME arrival of 19 April and also the possible hesitant coronal hole fast wind connection to CH25/-.
The above has likely increased electron populations at lower orbits, and as solar wind pressure eases into the new UTC working week, the observed flux at GEO is expected to increase to more reliable reach Moderate levels diurnally, perhaps increasingly peaking at High flux. This evolution is lower confidence however due to the chance of glancing CME arrivals which may serve to redistribute any increased counts into the period.

The associated 24-hour integrated electron fluence is expected to persist below the Active threshold, but with a Slight Chance of approaching this level later in the period on a slowly increasing trend. However the potential of glancing CME arrivals also reduces confidence. As such MOSWOC REFM is expected to offer reasonable guidance in the period, with an upward trend in the next 72 hours considered reasonable, albeit still peaking below Active. However potential glancing CME influence likely reducing model performance into the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	15
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM output



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